~~Technical Field~~ 043877-0142

FIELD OF THE INVENTION

[0001] ~~This~~The present invention generally relates to an injection apparatus ~~in~~ for a cold chamber die casting molding machine ~~. More~~ and, more specifically, ~~this invention~~ relates to an injection apparatus ~~,~~ which replenishes a light metal material into its melting device in the form of a ~~billet such as a~~ short cylindrical rod ~~for melting~~ billet, and supplies the molten metal into a plunger injection device ~~for measuring~~ . Moreover, ~~this~~ the present invention relates to a measuring method for the cold chamber die casting molding machine.

~~Background Art~~

DESCRIPTION OF THE RELATED ART

[0002] ~~An injection~~Injection molding machine for light metal alloys, such as magnesium, aluminum ~~,~~ or zinc ~~is~~ , are generally ~~called a~~ known as die casting molding ~~machine, and is classified into a~~ machines, and are categorized as either a "hot chamber method" machine ~~and~~ or a "cold chamber method" machine. The ~~former~~ hot chamber machine, ~~in~~ which positions an injection device ~~is provided~~ on a furnace, measures one shot of the molten metal in an injection sleeve of the injection device by sucking the molten metal from the furnace, and injects it into a mold cavity with a plunger. With ~~this~~ the hot chamber method ~~of~~ machine, ~~molten metal of~~ high temperature ~~is~~ molten metal is stably supplied ~~stably~~ into the injection sleeve. ~~On the other hand, the latter cold chamber machine, in which an injection sleeve is positioned out of a furnace, measures~~

~~the molten metal by transferring it from the furnace to the injection sleeve with a pump or a ladle, and injects it with a plunger. With this method of machine, since the injection device is provided separately from the furnace, maintenance work becomes easy.~~

[0003] Alternatively, the cold chamber method machine, which positions an injection sleeve outside of a furnace, measures the molten metal by transferring it from the furnace to the injection sleeve with a pump or ladle, and injects it with a plunger. With the cold chamber method machine, maintenance is easier, since the injection device is separated from the furnace.

[0004] The above-described conventional molding method machine have a high operating cost, since the size of the furnace is much larger than that of the molded articles, and since a great volume of molten metal needs to be kept at a specified high temperature. Additionally, it takes a long time to raise or lower the furnace temperature, and maintenance work may render a furnace inoperable for a whole day.

[0005] ~~However, with the above described method of molding machine, since the furnace has very bulky volume compared to that of molded articles and great volume of molten metal has to be kept at the specified high temperature, higher running cost is needed. In addition, it takes a long time to raise or lower the furnace temperature. Maintenance work for the furnace may need a whole day. Especially in case the molding material is~~ Moreover, and especially in the case of easily oxidized magnesium alloy ~~;~~ ~~since magnesium is extremely easy to be oxidized and to catch fire~~ molding materials, it is necessary to occasionally remove ~~sludge including~~ the magnesium oxide ~~. Moreover,~~ sludge. The surface area of the molten metal in the furnace is too large to prevent the

generation of the sludge, although much non-burning flux or inert gas is poured into the furnace ~~. To make matters worse~~ , and this sludge causes wear of the injection sleeve and the plunger.

[0006] ~~Therefore, an~~Conventional injection apparatus for supplying molding material directly to a plunger injection device without adopting the furnace ~~has been proposed. For example, an~~ are generally known in the art, such as injection apparatus having a material supply device capable of supplying light metal material in the form of a short cylindrical rod-shaped billet or ingot ~~, is known~~ . This type of ~~an~~ conventional injection apparatus generally injects semi-solidified molding material into the mold ~~. With this injection apparatus~~ , solving the ~~problem relating to the above described~~ furnace ~~is solved~~ -related problems and decreasing the potential for oxidation of a magnesium alloy ~~is also decreases~~ .

[0007] More specifically, ~~one of this injection apparatus is provided with a heating sleeve which accommodates plural ingots for heating preliminary, an injection sleeve which contains a plunger, and a chute which leads the ingot from the heating sleeve to the injection sleeve, wherein the ingots have been formed into the size for one shot of injection amount by other forming apparatus beforehand. (For example, see patent document 1, whose number is shown later) This injection apparatus transfers the ingots, which has been heated and softened in the heating sleeve, to the injection sleeve, and then injects the material, which has been turned into semi-molten state, into the mold with the plunger pressurizing. Another type of this injection apparatus is provided~~ Japanese Patent No. 2639552 provides for an injection apparatus with a heating sleeve which accommodates plural ingots for preliminary heating, an injection sleeve which contains a

plunger, and a chute which leads the ingot from the heating sleeve to the injection sleeve. The ingots are formed into the size for one shot of the injection amount beforehand, by other forming apparatus. This injection apparatus transfers the ingots, which have been heated and softened in the heating sleeve, to the injection sleeve. The material, which has been turned into semi-molten state, is injected into the mold with the plunger pressurizing.

[0008] Japanese Patent Laid-Open No. 2001-191168 provides another type of injection apparatus with a forming-hole (dice) and a cutter plate at the front end of a heating sleeve, which forms and cuts off the billet to ~~make it~~ match the injection sleeve, ~~wherein~~ where the billet corresponds to the above described ingot. ~~(See patent document 2) In~~ With this apparatus, the outside diameter of the billet is formed to fit with the inside diameter of the injection sleeve, and the overall length of the billet is cut off so as to become one shot of injection amount. Therefore, the troublesome problems ~~as shown in patent document 1, such as the increase~~ associated with Japanese Patent No. 2639552 are solved, increasing of the variety of the ingots and the related preliminary heating condition settings, ~~are solved, which makes~~ making it unnecessary to pre-prepare many kinds of ingots for every molded article ~~beforehand~~ .

[0009] ~~On the other hand, an~~Japanese Patent Laid-Open No. Rei 05-212531 proposes an alternative injection apparatus ~~different from the above described method apparatus is proposed. (See patent document 3) This injection apparatus has~~ with a high temperature cylinder section at mold side (the front side ~~close~~ closest to ~~a~~ the mold), a low temperature cylinder section at rear side (base side), and a heat insulating cylinder section between them. With this injection apparatus, ~~molding material, which is beforehand~~ a

pre-formed ~~into a~~ cylindrical molding material rod ~~,~~ is inserted into the above - described ~~-~~ injection cylinder, ~~and~~ is then ~~melts~~ melted in the high temperature cylinder section, and finally its molten metal is injected by the not-yet-melted molding material. Since the molding material is injected not by a plunger but rather by the not-yet-melted molding material itself, this molding material is ~~called~~ known as a "self-consumption plunger ~~in~~ ." Since this ~~specification. This~~ type of injection apparatus does not need a furnace, ~~so~~ it makes the structure of its melting device vicinity simple and also enables efficient melting. Moreover, this injection apparatus does not need a plunger, ~~which achieves reduction of~~ thus reducing the wear of the injection cylinder and ~~short time maintenance work.~~ reducing maintenance work time.

~~Afterward, the above applicant has proposed the similar injection apparatus (See patent document 4), but this document mainly discloses an injection apparatus for preventing seizure of glass forming.~~

~~Incidentally, the patent documents quoted above are:~~

~~Patent document 1 - Japanese patent No. 2639552,~~

~~Patent document 2 - Japanese patent laid-open No. 2001-191168,~~

~~Patent document 3 - Japanese patent laid-open No. Rei. 05-212531, and~~

~~Patent document 4 - Japanese patent laid-open No. Rei. 05-254858.~~

[0010] Although Japanese Patent Laid-Open No. Rei. 05-254858 provides a similar injection apparatus, this injection apparatus is primarily used for preventing the seizure of forming glass.

[0011] ~~However,~~The above -described injection apparatus of both the hot chamber method machine and the cold chamber method machine include some furnace-related problems ~~concerning the above described furnace.~~ . Also, the injection apparatus described in ~~the patent document 1 and 2,~~ Japanese Patent No. 2639552 and Japanese Patent Laid-Open No. 2001-191168, which do not contain ~~above described~~ a furnace, have such a limitation that they are not suitable for molding particularly thin walled and/or precise geometry articles, since they are do not ~~the apparatus to~~ inject fully molten metal. When ~~this type~~ these types of injection apparatus ~~tries~~ attempt injection with fully molten molding material ~~regardless of this limitation, the~~ , a longer waiting time is required ~~for changing~~ to change the material into a fully molten matter.

[0012] Japanese Patent Laid-Open No. Rei. 05-212531, which uses the self-consumption plunger, does not disclose the length of the molding material or its supply method. Moreover, Japanese patent laid-open No. Rei. 05-212531 does not describe the solution to the problem of impeded plunger movement, which often makes injection process impossible. This problem occurs since the molten metal, which has low viscosity and high pressure, flows backward through the gap between the injection sleeve and the self-consumption plunger, and then is solidified, accompanying increased frictional resistance.

[0013] ~~Another patent document 3, which adopts a -self consumption plunger, is neither disclosing the length of the molding material and its supply method. Moreover the patent document 3 is neither disclosing the solution for the following phenomenon although such a phenomenon occurs often. That phenomenon is that the movement of the plunger is impeded and so the injection becomes often impossible at the time of injection process,~~

~~since the molten metal, which has low viscosity and high pressure, flows backward through the gap between the injection sleeve and the self-consumption plunger, and then is solidified accompanying increased frictional resistance. That is because~~ Because the injection apparatus functions as an injection apparatus as well as a melting device ~~and hence~~ , the pressure of the molten metal becomes high. ~~Also, in~~ In the case where a self-consumption type plunger is installed horizontally in the injection sleeve, the above - described ~~phenomenon~~ problem becomes more remarkable, since the gap between the plunger and the injection sleeve ~~becomes~~ is larger at its ~~upper~~ raised side ~~. That is because~~ , since the outside diameter of the self-consumption plunger is manufactured ~~rather~~ somewhat thinner than the inside diameter of the injection sleeve anticipating thermal expansion. ~~Moreover, above described phenomenon becomes more pronounced in case the solidified matter of the molten metal is destroyed and re-formed at many times of injection molding operation and as a result grows up widely and hardly. In particular, in case of molding for particularly thin walled shape and/or particularly complicated geometry shape, the occurrence of the above phenomenon becomes more remarkable, since an injection is carried out under high speed and high pressure in this case.~~

[0014] The above-described problem also becomes more pronounced in the case where the solidified matter of the molten metal is destroyed and re-formed at many times of injection molding operation and, as a result, grows up widely and hardly. In particular, in the case of molding for a particularly thin-walled shape and/or a particularly complicated geometry shape, the occurrence of the problem becomes more remarkable, since an injection is carried out under high speed and/or high pressure conditions.

[0015] ~~Above described similar patent document 4 is neither solving the above phenomenon of light metal molding~~Japanese patent laid-open No. Rei. 05-254858 does not solve the above-described problem either, since it discloses ~~the~~ seizure prevention technology ~~of glass forming. That is, above described seizure prevention art is~~ for forming glass. Specifically, it describes cooling technology for promoting the cooling of molding material with ~~the~~ plural grooves or spiral grooves on the cylinder wall. In ~~this~~ the case of ~~glass~~ forming ~~, above described~~ glass, the operational effect at the ~~above~~ grooves ~~and so on~~ is supposed to be ~~actually~~ effective, since molten ~~grass~~ glass does not ~~fills~~ rapidly fill up ~~above described~~ the grooves ~~rapidly~~ because of high viscosity of its softened matter, at comparatively a wide temperature range inherent to glass. ~~On the contrary,~~ However in the case of light metal molding, light metal melts and solidifies rapidly due to small specific heat, small latent heat, and high coefficient of thermal conductivity inherent to light metal. ~~In addition, the temperature range at which light metal is in a softened state is narrower than that of glass and also the molten metal presents extremely low viscosity fluidity. Therefore the molten metal is intruded into the above described grooves rapidly and solidifies rapidly, and thus the grooves do not function as cooling grooves or as deformation absorption grooves. Accordingly, the injection apparatus in above described patent document 3 and document 4 are still incomplete to inject molten light metal stably.~~

[0016] Furthermore, the temperature range at which light metal is in a softened state is narrower than that of glass, and the molten metal also presents extremely low viscosity fluidity. Therefore the molten metal is rapidly intruded into the grooves and solidifies quickly, and thus the grooves do not function as cooling grooves or as deformation

absorption grooves. Accordingly, the conventional injection apparatus are still incomplete with regard to the stable injection of molten light metal.

[0017] ~~Therefore, the~~Accordingly, it is an object of ~~this~~ the present invention ~~is~~ to provide such an injection apparatus that makes the conventional furnace unnecessary ~~and makes~~ . In particular, it is desirable to make it possible to replenish a light metal material in the form of the billet and to supply said material into an injection device in the form of full molten material, ~~wherein said~~ where the injection apparatus can feed and melt a light metal materiel with efficiency and can measure one shot of injection amount of molten metal with accuracy.

~~Disclosure of the Invention~~

SUMMARY OF THE INVENTION

[0018] The present invention generally relates to an injection apparatus for a cold chamber die casting molding machine and, more specifically, relates to an injection apparatus which replenishes a light metal material into its melting device in the form of a short cylindrical rod billet, and supplies the molten metal into a plunger injection device. Moreover, the present invention relates to a measuring method for the cold chamber die casting molding machine.

[0019] According to a first arrangement, the present invention ~~,~~ is an injection apparatus in a cold chamber die casting molding machine ~~,~~ which supplies molten metal of a light metal material into a material supply mouth of an injection sleeve ~~and has~~ , the injecting sleeve having a plunger injection device ~~which injects said~~ for injecting the molten metal

~~by a~~ using an injecting plunger ~~, is comprising:~~ ~~(a)~~ . The injection apparatus includes a melting device ~~which melts said~~ for melting the light metal material, and a molten metal feeding member ~~which pours molten metal from said melting device to said plunger injection device;~~ ~~(b) wherein said~~ . The melting device further includes ~~:~~ a billet supplying device ~~which replenishes~~ , the billet supplying device replenishing the molding metal ~~by supplying said~~ using a plurality of cylindrical rod-shaped billets of the light metal material ~~in the form of a billet of the short cylindrical rod shape~~ , and a billet inserting device ~~which is situated behind said~~ disposed adjacent to the billet supplying device ~~and has a pusher for~~ , the billet inserting device moving ~~said replenished~~ each billet forward with an inserting plunger and/or ~~for~~ retreating the inserting plunger a distance which exceeds an overall length of ~~said~~ each billet ~~, and~~ a . The melting device also includes a first melting cylinder ~~which is~~ situated ~~in front of said~~ adjacent to the billet supplying device ~~for~~ obverse to the billet inserting device, the first melting cylinder accommodating ~~said plural~~ the plurality of billets moved forward by ~~said pusher~~ the inserting plunger and ~~for~~ incrementally melting ~~from~~ the ~~front end~~ plurality of ~~said~~ billets ~~so as~~ to ~~form~~ produce several shots of molten metal ~~;~~

~~(c) wherein said molten metal feeding member further includes a material supplying hole for pouring said molten metal from the front end of a cylinder bore of said melting cylinder to said material supply mouth of said injection sleeve; and~~ ~~(d) wherein said melting device measures said~~ , the melting device measuring the molten metal by pushing ~~said~~ each billet ~~via said pusher~~ with the inserting plunger and ~~by~~ supplying one shot of ~~said~~ the molten metal into ~~said~~ the injection sleeve after ~~said~~ the plunger injection device makes ~~said plunger retreat.~~ the inserting plunger retreat. The molten metal

feeding member is for pouring molten metal from the melting device to the plunger injection device, the molten metal feeding member forming a material supplying hole for pouring the molten metal from a distal end of a cylinder bore of the first melting cylinder to the material supply mouth.

[0020] The inside diameter of a portion of the cylinder bore distal to the billet inserting device matches the outside diameter of a solid, enlarged, heated billet so as to prevent backward flow of the molten metal, and the inside diameter of a portion of the cylinder bore adjacent to the billet inserting device is slightly larger than the outside diameter of each billet.

[0021] The injection apparatus further includes a cooling member, the cooling member cooling each billet and forming a through hole, the diameter of the through hole being larger than the outside diameter of each billet, the cooling member further including a cooling duct around the through hole. The injection apparatus also includes a second melting cylinder, the diameter of at least a portion of a cylinder bore of the second melting cylinder being greater than the diameter of each billet so as to prevent contact between the billet and the cylinder bore. Additionally, the injection apparatus includes a cooling sleeve disposed between the cooling member and the second melting cylinder, the cooling sleeve forming a circular groove, the circular groove cooling the molten metal and generating a circular solidified material on the molten material on the periphery of each billet.

[0022] The material supplying hole is in fluid communication with the cylinder bore of the first melting cylinder via a connecting passage, the connecting passage opening at an

upper portion of the cylinder bore of said first melting cylinder, and the first melting cylinder is inclined, with a front portion of the first melting cylinder in a high position.

[0023] The injection apparatus further includes an opening and shutting device disposed between the melting device and the plunger injection device, the opening and shutting device further including a valve rod for opening and shutting the bottom end of the material supplying hole by going up and down in the material supplying hole, and a valve rod driving device for opening the valve rod when measuring.

[0024] The material supplying hole stores the molten metal during measuring, and the inserting plunger and the valve rod operate substantially simultaneously.

[0025] By virtue of this type of structure, the melting device of the injection apparatus of this invention replenishes light metal material in the form of the billet of a short cylindrical rod shape, and melts ~~only the minimum~~ a minimal quantity for supplying the molten metal to the injection sleeve. Therefore, heating and solidifying in the melting cylinder can be done for a short time, and ~~hence~~ it ~~is~~ becomes possible to rapidly finish maintenance work of the injection apparatus ~~fast~~. Moreover the heating energy for melting the material in the melting device decreases ~~and hence~~ , making heating ~~becomes~~ efficient. Also, the volumetric size of the melting device ~~becomes~~ is remarkably smaller than that ~~with~~ of the conventional furnace. In addition, the handling ~~becomes~~ is easy because the light metal material is supplied in the form of the billet. In ~~particular, in~~ case the billet is magnesium material, another advantage is that it is difficult for the billet to oxidize ~~is gained~~ .

[0026] ~~Preferably, said~~The melting cylinder of said injection apparatus in a cold chamber die casting molding machine ~~is composed by such~~ includes a first melting cylinder such that most of a cylinder bore, except for the base side of ~~said~~ the first melting cylinder, is formed to have an inside diameter which keeps ~~said~~ most of the cylinder bore ~~into~~ in contact with an enlarged side surface of the not-yet-melted front end of said billet ~~with the~~ to such a degree ~~which prevents~~ that the backward flow of ~~said~~ the molten metal ~~, and a~~ is prevented. The cylinder bore of ~~said~~ the base side of ~~said~~ the first melting cylinder is formed to have a slightly larger diameter than an outside diameter of ~~said~~ the billet.

[0027] With this construction of the injection apparatus ~~of this invention~~, the melting device ~~is composed by such~~ includes a first melting cylinder such that most of the cylinder bore of the first melting cylinder ~~which excludes~~ , excluding the base side, is formed to have an inside diameter which keeps said most of the cylinder bore ~~into~~ in contact with the enlarged side surface of front end of billet with the degree which prevents the backward flow of the molten metal at the time of measuring ~~, and that the~~ . The cylinder bore of the base side is formed to have such an outside diameter that is a slightly larger than that of the billet. ~~Therefore~~ As such, the enlarged side surface prevents the backward leakage of the molten metal ~~to the backward~~ and the ~~invasion~~ introduction of air and the like into the molten metal as an enlarged diameter seal member and hence functions as the seal with small frictional resistance. ~~Moreover, since the first melting cylinder and the pusher do not contact each other, they are not badly worn and maintenance work of the melting device becomes easy. This type of melting~~

~~cylinder is so simple that it is effective when it is adopted for a small-sized injection molding machine.~~

[0028] Since the first melting cylinder and the plunger do not contact each other, they are not quickly worn, minimizing required maintenance work for the melting device. This type of melting cylinder is so simple that it is effective when it is adopted for a small-sized injection molding machine.

[0029] ~~Preferably, said~~The melting device of ~~said~~ the injection apparatus ~~in a cold chamber die casting molding machine is comprising:~~

~~(a) a cooling member which cools said billet,~~

~~a second melting cylinder which is fixed in front of said cooling member, and~~

~~a cooling sleeve which is situated between said second melting cylinder and said cooling member;~~

~~(b) wherein said cooling member has a through hole with a diameter a slightly larger than the outside diameter of said billet and has a cooling duct around said through hole;~~

~~(c) wherein most of the cylinder bore of said second melting cylinder is formed to have an inside diameter which does not allow said most of the cylinder bore to come into contact with said front end of said billet; and~~

~~(d) wherein said cooling sleeve has a circular groove which generates a circular solidified material of said molten metal on the periphery of said billet by cooling said molten metal~~ ~~With this construction, the melting device of the injection apparatus. of this invention~~ contains ~~such~~ a cooling sleeve between ~~said~~ the second melting cylinder and a cooling member, ~~that said~~ the cooling member ~~has the~~ having a hole ~~of~~ the

inside diameter of which is a slightly larger than the outside diameter of the ~~above described~~ billet ~~, and that said most~~ . Most of the cylinder bore of the second melting cylinder is formed to have an inside diameter which does not allow ~~said~~ most of the cylinder bore to come into contact with the front end of the billet, and ~~that~~ the cooling sleeve has a circular groove which generates a circular solidified matter from said molten metal by cooling it. ~~Therefore the circular solidified material prevents the leakage of the molten metal to the backward and the invasion of air and the like into the molten metal as a circular solidified material seal, and also functions as a seal with small frictional resistance. This type of melting cylinder is effectively adopted at a large sized injection molding machine as well as a small-sized injection molding machine.~~

[0030] Therefore the circular solidified material prevents the backward leakage of the molten metal and the introduction of air and the like into the molten metal as a circular solidified material seal, and also functions as a seal with small frictional resistance. This type of melting cylinder can be effectively adopted by both small and large-sized injection molding machines.

[0031] ~~Preferably, said~~The material supplying hole of ~~said~~ the molten metal feeding member of ~~said~~ the injection apparatus in a cold chamber die casting molding machine leads to ~~said cylinder~~ the cylindrical bore of ~~said~~ the melting cylinder via a connecting passage ~~that~~ . The connecting passage is an opening at the upper portion of ~~said~~ the cylinder bore of ~~said~~ the melting cylinder and ~~, said~~ the melting cylinder is arranged in the inclined posture in which the front portion is high position.

[0032] ~~With this construction of the injection apparatus of this invention, the~~The material supplying hole of the molding material feeding member leads through a connecting passage which opens at the upper portion of the cylinder bore of the melting cylinder, and the melting cylinder is arranged in the inclined posture with its front side high. Therefore the air and the gas which remains in the melting cylinder is, at first ~~is purged~~ , promptly purged, and the ~~phenomenon~~ problem in which molten metal in the melting cylinder ~~over-flows~~ unexpectedly overflows into the injection sleeve ~~at unexpected timings~~ except for the measuring timing is prevented, ~~which ensures the~~ ensuring measuring ~~accurate~~ accuracy.

[0033] Preferably, ~~such~~ an injection apparatus opening and shutting device ~~of said injection apparatus in a~~ for cold chamber die casting molding is provided between ~~said~~ the melting device and ~~said~~ the plunger injection device ~~, that~~ . The opening and shutting device contains a valve rod for opening and shutting the bottom end of ~~said~~ the material supplying hole by ~~going~~ moving up and down in ~~said~~ the material supplying hole, and a valve rod driving device for opening ~~said~~ the valve rod ~~only~~ at the time of measuring.

[0034] With this type of structure, ~~since said~~the valve rod opens the bottom end of ~~said~~ the material supplying hole ~~only~~ at the ~~timing~~ time of measuring, preventing the unexpected dropping of the molten metal in the material supplying hole ~~at unexpected timings except for~~ other than the measuring ~~timing is prevented, which assures~~ times, assuring accurate measuring.

[0035] The measuring method used in ~~said injection apparatus in a~~the cold chamber die casting molding machine injection apparatus, in which ~~said~~ the opening and shutting device opens and shuts ~~said~~ the material supplying hole, ~~is performed as follows that said~~ occurs by measuring the molten metal ~~is measured~~ in such a manner that ~~said~~ the molten metal is always stored in ~~said~~ the material supplying hole with the opening and shutting operation of ~~said~~ the material supplying hole and the extruding operation of ~~said pusher~~ the plunger performed almost simultaneously.

[0036] In this measuring method, since the opening and shutting operation of the material supplying hole by means of the opening and shutting device and the extruding operation of molten metal by means of the ~~pusher~~plunger are performed simultaneously, solidification of molten metal in the material supplying hole is prevented ~~and moreover~~ . Furthermore, adhesion of molten metal to the material supplying hole or the valve rod is ~~evaded, which ensures~~ prevented, ensuring accurate measurement control.

[0037] In the following description of the preferred embodiment, reference is made to the accompanying drawings that form a part thereof, and in which is shown by way of illustration a specific embodiment in which the invention may be practiced. It is to be understood that other embodiments may be utilized and changes may be made without departing from the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

[0039] Figure 1 is a cross-sectional elevation view showing the outline structure of an injection apparatus in a cold chamber die casting molding machine according to one arrangement of the present invention;

[0040] Figure 2 is a cross-sectional view showing a first melting cylinder according to one aspect of the present invention;

[0041] Figure 3 is a cross-sectional view showing a second melting cylinder according to a second aspect of the present invention;

[0042] Figure 4 is an enlarged cross-sectional view of base portion of the Figure 3 second melting cylinder;

[0043] Figure 5 is an enlarged cross-sectional view showing structure of a opening and shutting device equipped in a molten metal feeding member according to one arrangement of the present invention; and

[0044] ~~Fig. 1 is a cross-sectional elevation view showing outline structure of an injection apparatus in a cold chamber die casting molding machine of this invention. Fig. 2 is a cross-sectional view showing a first melting cylinder for the first embodiment of this invention. Fig. 3 is a cross-sectional view showing a second melting cylinder for the second embodiment of this invention. Fig. 4 is an enlarged cross-sectional view of base~~

~~portion of the second melting cylinder illustrated in Fig. 3. Fig. 5 is an enlarged cross-sectional view showing structure of a opening and shutting device equipped in a molten metal feeding member of this invention. Fig.~~ Figure 6 is a cross-sectional view, taken along line X - X of Fig. 1, showing a billet supplying device of an injection apparatus in a cold chamber die casting molding machine ~~of this~~ according to one arrangement of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0045] ~~An~~The present invention provide an injection apparatus, that obviates the need for a furnace. Specifically, the present invention makes it possible to replenish a light metal material in the form of the billet and to supply said material into an injection device in the form of full molten material, where the injection apparatus can feed and melt a light metal materiel with efficiency and can measure one shot of injection amount of molten metal with accuracy. The injection apparatus in a cold chamber die casting machine ~~of this~~ according to the present invention is described ~~as follows~~ below, using illustrative embodiments.

[0046] Initially, the light metal material which is to be supplied into the injection apparatus is described, below. The light metal material is formed into a shape of a short rod, or "billet", which is pre-cut from a cylindrical bar, to a specified length. Referring to Figure 1, the periphery surface and cut off end surface of billet 2 are finished smooth. The outside diameter of billet 2 is formed to be 0.2 mm to 0.5 mm thinner than the inside diameter of a base end (right end) side of a cylinder bore 11a of a melting cylinder 11 when billet 2 has expanded after heated, as described below.

[0047] ~~First of all, light metal material to be supplied into this injection apparatus is described. The light metal material is formed into a shape of a short rod which is cut off beforehand at a specified length from a cylindrical bar. This light metal material is hereinafter called a billet. Reference numeral 2 denotes the billet, and its periphery surface and cut off end surface is finished smooth. The outside diameter of this billet is formed to secure 0.2 mm to 0.5 mm thinner than the inside diameter of a base end side (the right side in the drawing) of a cylinder bore 11a of a melting cylinder 11 when this billet has expanded after heated as described later. The length of this~~ The length of billet 2 is formed to correspond to the volume of from ~~ten several~~ tens of shots to a ~~few~~ several tens of shots of the injection amount ~~;~~ and, ~~for~~ in one example, is formed to be ~~about~~ approximately 300 mm to 400 mm ~~for the sake of~~ long, to ease its handling. Since the light metal material is supplied in this form of a billet, storage and handling of the materials ~~becomes~~ is easy. ~~Especially in~~ In the case where the billets 2 are made of magnesium material, the billets ~~have such an advantage that they~~ are more difficult to oxidize than the palletized metal which is ~~used~~ conventionally used in ~~the~~ thyrotrophic molding, since the surface area with respect to the volume is small. ~~Incidentally the above described one shot of injection amount is the sum of the volume of molten metal for one shot injection, which involves the volume of molded articles and the accompanying volume, such as a spool, runner, and the thermal shrinkage volume.~~

[0048] Incidentally, the above-described one shot of injection amount is the sum of the volume of molten metal for one shot injection, which includes the volume of the molded articles and the accompanying volume, such as a spool, runner, and the thermal shrinkage volume.

[0049] ~~Next, the~~An outline of ~~the~~ several example embodiments of the injection apparatus in a cold chamber die casting molding machine ~~of this~~ according to the present invention is described, below. As shown in Fig. 1, ~~this~~ the injection apparatus 1 includes a melting device 10, a plunger injection device 20, and a molten metal feeding member 15 which pours molten metal from the melting device 10 to the plunger injection device 20.

[0050] The melting device 10 is different from the conventional injection apparatus of cold chamber die casting molding machine, since the light metal material is replenished in the form of billets, which are described above. The melting device 10 includes the melting cylinder 11, a billet supplying device 40 and a billet inserting device 50. The melting cylinder 11 and the billet inserting device 50 are fixed to a central frame member 90.

[0051] The central frame member 90 is used for mounting the billet supplying device 40 and is composed of four rectangular side plates 90a and a single bottom plate. In one of the two opposing plates 90a, a through hole 90b is formed having a diameter slightly larger than the outside diameter of a billet 2. In the other of opposing plates 90a, a through hole 90c is formed, in which a plunger 52a moves forward and backward, as is described more fully below.

[0052] ~~The melting device 10 is different from the conventional injection apparatus of cold chamber die casting molding machine in such a manner that light metal material is replenished in the form of billets as described above. This melting device 10 comprises the melting cylinder 11, a billet supplying device 40 and a billet inserting device 50. The~~

~~melting cylinder 11 and the billet inserting device 50 are fixed to a central frame member 90. The central frame member 90 is a member for mounting the billet supplying device 40 and is composed of four rectangle side plates 90a and a single bottom plate. In one of two opposing plates 90a, a through hole 90b having a diameter slightly larger than the outside diameter of a billet 2 is formed. In the other of opposing plates 90a, a through hole 90c is formed, in which a pusher 52a goes forward and backward as described later.~~ The melting cylinder 11 is a long cylinder formed to have such a length as to accommodate plural billets 2. Most of the cylinder bore 11 a, except for the vicinity of the base end, is formed to have a larger diameter than that of a billet ~~2~~ 2, as is described ~~later.~~ more fully below. The front end of ~~this~~ the cylinder bore 11 a is blocked by an end plug ~~13~~ 13, but the cylinder bore 11 a leads to a material supplying hole ~~15~~ 15a in the molten metal feeding member ~~15~~ 15, as is described ~~later.~~ more fully below. With the melting device 10 composed in this way, the billets 2 are replenished one by one to the rear of the melting cylinder 11 by the billet supplying device ~~40, and~~ 40. The billets 2 are inserted into the melting cylinder 11 by the plunger 52a of the billet inserting device ~~50~~ 50, so as to melt from ~~its front end. The amount of molten metal 3 is controlled to secure several shots of injection amount as described later. The more detail of the melting cylinder 11, the molten metal feeding member15, the billet supplying device 40 and the billet inserting device 50 is described later.~~ their front end.

[0053] The amount of molten metal 3 is controlled to secure several shots of injection amount, as is described more fully below. The melting cylinder 11, the molten metal feeding member 15, the billet supplying device 40 and the billet inserting device 50 are also described below as well.

[0054] The plunger injection device 20 is similar to that of the conventional injection apparatus in a cold chamber die casting molding machine, and includes an injection sleeve 21, a plunger 22 and a plunger driving device 60. The injection sleeve 21 and the plunger driving device 60 are arranged in series on a single line by a connecting member 64.

[0055] The injection sleeve 21 has a sleeve bore 21a for temporarily storing molten metal 3, and has a material supply mouth 21h on the upper portion, through which molten metal 3 is poured. The front (left) end of the injection sleeve 21 goes through a stationary platen 31 and a mold half 32.

[0056] ~~The plunger injection device 20 is basically the same as that of the conventional injection apparatus in the cold chamber die casting molding machine, and includes an injection sleeve 21, a plunger 22 and a plunger driving device 60. The injection sleeve 21 and the plunger driving device 60 are arranged in series on a single line by a connecting member 64. The injection sleeve 21 has a sleeve bore 2la for storing molten metal 3 temporarily and has a material supply mouth 2lh on the upper portion, through which molten metal 3 is poured. The front end (the left side in the drawing) of the injection sleeve 21 goes through a stationary platen 31 and a mold half 32.~~ The plunger 22 is connected at its base end to a piston rod 62 of the plunger driving device 60, and is subjected to ~~control of~~ controlled movement in a longitudinal direction ~~in~~ within the injection sleeve 21. ~~This~~ The plunger injection device 20 ~~mounts~~ supports the melting device 10 via the central frame member 90. The central frame member 90 is ~~fixed~~ affixed on a connecting base member 92 arranged on the plunger driving device 60. The plunger driving device 60 is placed on a slide base 91 of a machine base frame (not

depicted). ~~(Not shown in the drawing) The plunger injection device 20 fills molten metal 3 into a cavity 34 with the plunger 22. The more detail of the injection sleeve 21, the plunger 22, the connecting member 64 and the plunger driving device 60 are described later. Incidentally the mold halves 32 and 33 compose conventional mold unit, the mold half 32 is fixed on the stationary platen 31 of a clamping device 30, and so the cavity 34 is formed when the mold halve~~

[0057] The plunger injection device 20 fills molten metal 3 into a cavity 34 with the plunger 22. Additional details relating to the injection sleeve 21, the plunger 22, the connecting member 64 and the plunger driving device 60 are described below. Incidentally, the mold halves 32 and 33 comprise a conventional mold unit, where the mold half 32 is fixed on the stationary platen 31 of a clamping device 30, and where the cavity 34 is formed when the mold half 33 is closed.

[0058] The material supplying hole 15a in the molten metal feeding member 15 ~~fixed~~is affixed near the front (left) end of the melting cylinder 11 ~~leads~~ leading to the cylinder bore 11 a through ~~a~~ connecting ~~passage~~ passages 13a and 13b in the end plug 13. The lower portion of the molten metal feeding member 15 and the material supply mouth 21 h are covered with a cover 16. A pouring hole 17 through which inert gas is filled leads to the connecting passage 13a, the material supplying hole 15a and/or the ~~covet~~ cover 16. For example in ~~Fig.~~ Figure 1, ~~this~~ the pouring hole 17 is formed in the end plug 13, whereas in ~~Fig. 5 it~~ Figure 5 the pouring hole 17 is formed on the cover ~~16~~ 16, as is described ~~later.~~ below. Inert gas filled through ~~this~~ the pouring hole 17 purges out air in the material supplying hole 15a and the injection sleeve 21. ~~The~~ This purge prevents the

oxidation of the molding material, such as easily-oxidizable magnesium ~~alloy which is easy to oxidize is particularly prevented by this purge.~~ alloys.

[0059] On the melting cylinder 11 of the injection apparatus 1, for example, band heaters 12a, 12b, 12c and 12d, are wrapped so as to melt the billet 2 from its front end to its back end. Moreover, a heater band 18 and a heater band 23 are wrapped around the molten metal feeding member 15 and the injection sleeve 21 so as to keep molten metal 3 in a molten state.

[0060] ~~On this type of the melting cylinder J 1 of the injection apparatus 1, for example, heaters 12a, 12b, 12c and 12d like heater bands are wrapped so as to melt the billet 2 from its front end first. Moreover, a heater band 18 and a heater band 23 are wrapped around the molten metal feeding member 15 and the injection sleeve 21 so as to keep molten metal 3 in a molten state. These~~ The aforementioned heater bands control their ~~vicinities~~ surroundings to a specified set up temperature based on the feedback temperature from sensors (not ~~shown in the drawing.~~ depicted). For example, in case a billet 2 is magnesium alloy, the temperature of the heater bands 23 and 18 is set to about 600 ~~DC~~ °C to 650 ~~DC. Temperature~~ °C. The setting of temperatures for heater bands 12a, 12b, 12c and 12d are described in greater detail ~~later. Incidentally, melting~~ , below. Melting cylinder 11 ~~may be~~ is made of ceramics and ~~the like, and~~ or a similar material, so the heater bands ~~may~~ can be ~~an~~ induction-heating ~~coil~~ coils.

[0061] Next, ~~the~~one example embodiment of the melting device 10 ~~that discloses~~ which includes the characteristic features of ~~this~~ the present invention ~~the most~~ is described in detail ~~. First of all, two embodiments of the melting cylinder 11 are described. Fig.~~ ,

below. Figure 2 is a cross-sectional side view showing the first example embodiment ~~.~~ ~~Fig.~~ of the melting cylinder 11, and Figure 3 is a cross-sectional side view showing the second example embodiment ~~, Fig.~~ of the melting cylinder 11. Fig. 4 is an enlarged cross-sectional view of the base portion of ~~Fig. 3.~~ the Figure 3 embodiment.

[0062] ~~Reference numeral 111 in Fig. 2 denotes~~Figure 2 depicts the first melting cylinder 111 of the first example embodiment. Most of a cylinder bore 111 a of ~~this~~ the cylinder ~~111 except for the vicinity of~~ 111, with the exception of the portion near the base end, is formed to have a few ~~mm~~ millimeters larger of a diameter than the billet ~~2~~ 2, and the base end of ~~this~~ the cylinder bore 111 a has a slightly larger diameter than the billet ~~2. Between them,~~ 2, forming a stepped section 111 ~~d is formed.~~ d in between. In case ~~this~~ the melting cylinder is used for melting magnesium alloy, the gap of a larger diameter cylinder bore 111 b with regard to the billet 2 is formed ~~to secure~~ with a clearance of about 1 ~~from~~ mm to ~~2 from.~~ 2. Also, the gap of a base end side of the cylinder bore 111 c with the billet ~~2~~ 2, which has slightly expanded ~~thermally slightly, is formed to secure about 0.2 from to 0.5 mm. The position of the stepped section 111 d is formed beforehand at an appropriate position in accordance with some conditions, such as the inside diameter of the melting cylinder lll, the volume of molten metal 3, temperature setting of the heater band 12c, 12d, or the gap of the larger diameter cylinder bore 111 b with the billet 2. Incidentally, the inside diameter of a cylinder bore lllc of base end side represents a cylinder diameter which shows one of specification indexes of the injection machine.~~ due to heat, is formed with a clearance of about 0.2 to 0.5 mm.

[0063] The position of the stepped section 111d is formed at an appropriate position in accordance with certain conditions, such as the inside diameter of the melting cylinder

111, the volume of molten metal 3, temperature setting of the heater bands 12c and 12d, or the gap of the larger diameter cylinder bore 111b with the billet 2. The inside diameter of a cylinder bore 111c of base end side represents a cylinder diameter which shows one of specification indexes of the injection machine.

[0064] Figure 3 denotes a second melting cylinder 211 according to a second example embodiment of the present invention. The melting cylinder 211 is combined with its base end to the side plate 90a of the central frame member 90 by bolts 213 along with a cooling sleeve 212 which is described in more detail, below. According to the second example embodiment, a cooling duct 90d is formed at the periphery of the through hole 90b of the side plate 90a, for circulating cooling fluid. As such, the side plate 90a functions as a cooling member and is referred to as a cooling member 214 in the following description.

[0065] ~~Reference numeral 211 in Fig. 3 denotes a second melting cylinder of the second embodiment. This melting cylinder 211 is combined with its base end to the side plate 90a of the central frame member 90 by bolts 213 along with a cooling sleeve 212 which is described later. In this embodiment, a cooling duct 90d for circulating cooling fluid is formed at the periphery of the through hole 90b of the side plate 90a. Therefore the side plate 90a functions as a cooling member and hence is also called a cooling member 214 in the following description. As a matter of course, this cooling member 214 may be composed as the different part~~ The cooling member 214 is formed apart from the side plate 90a, and ~~may be~~ is arranged ~~at any place as long as it is furnished~~ anywhere between melting cylinder 211 and the side plate 90a. ~~In case~~ If the billet 2 is comprised of magnesium alloy, the gap between the through hole 90b and the billet 2 is formed to

~~secure~~ have a clearance of about 0.2 mm to 0.5 mm when the billet 2 has ~~expanded~~ thermally ~~slightly~~ expanded. Owing to ~~this~~ the gap in the through hole 90b and ~~this~~ the cooling operation ~~by~~ of side plate 90a, billets 2 are inserted without interfering with the through hole 90b, and ~~is~~ are maintained in ~~such~~ a non-softened state so that the billet 2 does not deform with the pressure of molten metal 3 which slightly rises ~~a little at the time of~~ during measuring.

[0066] The inside diameter of the cylinder bore 211a of ~~above described~~the second melting cylinder 211 is formed a few ~~mm~~ millimeters larger than billet 2. For example, in the case where the molding metal is comprised of magnesium alloy, the gap ~~with respect to the billet 2~~ is formed about 1 ~~mm~~ to 3 ~~mm larger. The operational effect of this gap is described later. The~~ millimeters larger than the billet 2, for reasons described below. As depicted in Figure 4, the melting cylinder 211 also has an annular protrusion 211 e of the shape of the sleeve on the outer side of the base end ~~as shown in Fig. 4, and forms~~ , forming a space 215 in combination with the cooling sleeve ~~212,~~ 212 and the cooling member 214. ~~This~~ The annular protrusion 211 ~~e has plural~~ e forms a plurality holes or cutouts 211 f from which heat which is confined in ~~this~~ the space 215 is dissipated. ~~Therefore this~~ Accordingly, the space 215 functions as a heat insulating space between the cooling member 214 and the melting cylinder 211.

[0067] The cooling sleeve 212, fixed between the base end of the melting cylinder 211 and the side plate 90a of a cooling member 214, is formed to be a small and substantially thin cylindrical member, so that ~~the contact surfaces to them become as small as possible. This~~ surface contact is minimized. As illustrated in Figure 4, the cooling sleeve ~~212, as shown in Fig. 4,~~ 212 is fitted in a bored hole on the front surface of cooling

member 214 and a bored hole on the base end of melting cylinder 211. ~~This~~ The cooling sleeve 212 also has a temperature sensor ~~not shown in the drawing and its~~ (not depicted) to detect temperature ~~is detected~~ .

[0068] ~~In~~As shown in Figure 4, in a hole ~~of~~ formed in the cooling sleeve 212, ~~as shown in Fig. 4, an~~ a circular groove 212a is formed, in which molten metal 3 ~~flown~~ which has flowed backward along the periphery of the billet 2 is solidified and ~~held. This~~ kept. In the case where billets 2 are comprised of magnesium alloys, the circular groove 212a is formed to be 20 mm to 40 mm in width ~~,~~ (preferably 30 mm), and 3 mm to 4 mm in depth with respect to the cylinder bore 211 ~~a in case the billets 2 are magnesium alloys. Besides, the~~ a. The inside diameter of a hole 212b of the cooling sleeve 212 at the front side of the circular groove 212a is formed to be equal to that of cylinder bore 211 a, and the inside diameter of a hole 212c at the ~~backward~~ back side of the circular groove 212a is formed to be equal to that of the through hole 90b. ~~Since the circular groove 212a is formed in the cooling sleeve 212 which contacts the cooling member 214, the circular groove 212a is cooled powerfully by the cooling member 214. The operational effect of this circular groove 212a is described later. Incidentally, the circular groove 212a is formed to be contained completely in the cooling sleeve 212 as shown in Fig. 4, but it may be formed to have a contact with either side of the melting cylinder 211 or the cooling member 214.~~

[0069] Since the circular groove 212a is formed in the cooling sleeve 212, which contacts the cooling member 214, the circular groove 212a is powerfully cooled by the cooling member 214. The operational effect of the circular groove 212a is described in more detail, below. The circular groove 212a is formed to be completely contained in the

cooling sleeve 212, as shown in Figure 4, but it may be formed to have a contact with either side of the melting cylinder 211 or the cooling member 214.

[0070] ~~In particular, it~~It is ~~desirable~~ desired that the cooling sleeve 212 ~~is~~ be made of ~~such~~ a similar material ~~that is equivalent~~ to the melting cylinder 211 and/or the cooling member ~~214 in~~ 214, with respect to rigidity and thermal expansion ~~, and is~~ . It is also desired that the cooling sleeve be made of the material that has as good thermal conductivity as possible. This means that cooling sleeve 212 may be formed together with either the melting cylinder 211 or the cooling member 214.

[0071] Moreover, the cooling sleeve 212 has no problem in stiffness ~~although~~, despite being made of a small volume member, as illustrated, ~~namely,~~ specifically a comparatively thin cylindrical member. That is because a circular solidified material ~~20 1,~~ 201, which is formed in the . circular groove 212a as described ~~later~~ below, prevents molten metal 3 from leaking backward beyond ~~this~~ the circular solidified material 201 and ~~hence~~ thus suppresses high pressure.

[0072] With regard to above -described heater bands 12a, 12b, 12c and 12d of the first melting cylinder 111 and the second cylinder 211, three front side heater bands 12a, 12b and 12c are set to the melting temperature of the billets 2. For example, in case billet 2 is magnesium alloy, temperature of these heater bands are set to about 600 °C to 650 ~~+~~ °C. On the ~~contrary,~~ other hand, the temperature setting of the heater band 12d for the first melting cylinder 111 and that for the second cylinder 211 ~~differs a little~~ may vary.

[0073] The temperature setting of heater band 12d of the first melting cylinder 111 is ~~controlled~~ appropriately ~~at~~ controlled to about 450°C to about 550 °C, so as to suppress

the softening of billet 2 ~~that~~ which is positioned at the base end of melting cylinder ~~lll. That is~~ 111, because magnesium ~~alloy~~ alloys begins to ~~soften~~ materially soften when ~~it is~~ they are heated to about 350°C. By being heated in this ~~way~~ manner, the billet 2 is ~~preliminary~~ preliminarily heated to the extent that it does not soften in the base end of the melting cylinder ~~lll,~~ 111, then it is heated at high temperature in the portion from the halfway point to the front end of the cylinder 111 while advancing inside the cylinder bore 111 ~~a, and finally~~ a. Finally, the billet 2 melts rapidly into molten metal 3 ~~of~~ at a temperature of 600°C to 650 ° ~~c~~ C at the front end of the cylinder ~~lll. In~~ 111. According to this embodiment, the side plate 90a of the central frame member 90 is ~~not heated~~ generally not heated, and so in some cases the plate 90a ~~, in some case,~~ may be cooled by ~~the~~ a cooling pipe ~~like~~ similar to the cooling duct 90d of the second melting cylinder 211.

[0074] On the other hand, the heater band 12d of the second melting cylinder 211 is fixed at the position apart from the vicinity of the base end, where the cooling sleeve 212 is attached, and heating influence to the cooling sleeve 212 is suppressed as much as possible. The temperature setting of the heater band 12d is controlled to about 500°C to 550 °C. As such, the cooling sleeve 212 is not subjected to heating but is cooled strongly by the cooling member 214.

[0075] ~~On the other hand, the heater band 12d of the second melting cylinder 211 is fixed at the position apart from the vicinity of the base end where the cooling sleeve 212 is attached, and heating influence to the cooling sleeve 212 is suppressed as much as possible. The temperature setting of the heater band 12d is controlled at about 500°C to 550 °C. Therefor, the cooling sleeve 212 is not subjected to heating but is cooled~~

~~strongly by the cooling member 214. Accordingly,~~ The temperature of cooling sleeve 212 is primarily controlled ~~mainly~~ by the cooling temperature setting of the cooling member 214, and is ~~subsidiary~~ partially controlled by ~~this~~ the heater band ~~12d. As a matter of course, the~~ 12d. The plumbing through which the coolant ~~goes may~~ flows can be ~~turned~~ reversed around the cooling sleeve 212 and the temperature ~~may~~ can be individually controlled. ~~More specifically, in~~ In the case of magnesium ~~molding,~~ alloy moldings, the temperature of billet 2 in the cooling member 214 ~~may~~ can be cooled down as not to exceed ~~about~~ approximately 100°C to ~~ISO~~ 150°C, and temperature of billet 2 in the cooling sleeve 212 may be controlled to ~~become~~ about 400°C, which is ~~close to~~ near the temperature 350 °C at which the some softening occurs ~~a little~~ .

[0076] Since the billet 2 is heated in the first melting cylinder 111 or in the second melting cylinder 211 as described above, the billet 2 melts from its front end and turns into molten metal 3. ~~Then,~~ The temperature is controlled so that several shots of the injection amount ~~is~~ are secured, while the volume of ~~this~~ the molten metal 3 fluctuates at every ~~time of the measuring process of~~ point during the molding operation ~~. In this manner, the minimum~~ measuring process. A minimal amount of material is ~~only~~ melted and secured in the melting device ~~10~~ 10, and ~~thus~~ heat energy is ~~reduced~~ efficiently ~~. Moreover,~~ reduced. The time for raising or cooling down the temperature is reduced, ~~which minimizes wasteful~~ minimizing wasted waiting time for maintenance ~~work~~ and inspection work. Moreover, the ~~volumetric size~~ volume of the melting device becomes much smaller than ~~the~~ conventional ~~furnace~~ furnaces.

[0077] ~~As a matter of course,~~ The backward flow of molten metal 3 through the gap between the billet 2 and the melting cylinder 11 ~~has to be surely~~ is prevented when one

shot of molten metal 3 ~~for one shot amount~~ is supplied to the injection sleeve 21 from the melting cylinder 111 or ~~211, namely measured.~~ 211 for measurement. Such sealing is done by the ~~following~~ below-described method in both the first melting cylinder 111 and the second melting cylinder 211.

[0078] In the first embodiment, at the time of measuring, the front end of the softened billet 2 is enlarged diametrically ~~a little~~slightly due to ~~a little~~ the slight rising pressure ~~rising~~ of the molten metal 3. ~~Then a~~ A side surface 2a of the enlarged front end seals molten metal 3 by being appropriately kept into contact with the wall surface of the larger diameter cylinder bore 111 b appropriately. This sealing is performed when ~~this~~ the enlarged side surface 2a appropriately keeps contact with the wall surface of the cylinder bore 111 ~~b appropriately~~ b, and ~~hence~~ this sealing is realized by the appropriate gap size between them. ~~In this case, it is convenient that the pressure rise of molten metal 3 at the time of measuring is a little, which does not cause the diametrical expansion of above described side surface 2a too much. Moreover, eccentricity of the billet 2 with the cylinder bore 111 b is suppressed and hence the gap between the base end side cylinder bore 111 c and billet 2 becomes small and is minimized equally. In addition, the side surface 2a keeps contact with the cylinder bore 111 b appropriately as a soft and uniformly enlarged seal, since such a surface 2a is kept in the appropriately softened state by heating of the heater bands 12a to 12d and cooling of the cooling member 214. Therefore the side surface 2a functions as a seal of low frictional resistance and as a seal which also prevents intrusion of air and the like or leakage of molten metal 3. Accordingly the side surface 2a enlarged diametrically of this embodiment is termed an enlarged diameter seal member in the following description.~~

[0079] It is convenient that the rising pressure of the molten metal 3 is small at the time of measuring, preventing much of the diametrical expansion of the side surface 2a. Eccentricity of the billet 2 with the cylinder bore 111b is suppressed and the gap between the base end side cylinder bore 111c and billet 2 becomes small and equally minimized.

[0080] The side surface 2a keeps appropriate contact with the cylinder bore 111b as a soft and uniformly enlarged seal, since such a surface 2a is kept in the softened state by the heating of the heater bands 12a to 12d and the cooling of the cooling member 214. The side surface 2a functions as a low frictional resistance seal, and prevents intrusion of air and the like, or the leakage of molten metal 3. Accordingly the dramatically enlarged side surface 2a according to this embodiment is referred to as an "enlarged diameter seal member."

[0081] ~~In~~According to this embodiment, the gap between the larger diameter cylinder bore 111 b and the billet 2 ~~has to be set up beforehand appropriately~~ is appropriately pre-set in accordance with the aforementioned molding condition ~~as described above. However above described first~~ . First melting cylinder 111 can be ~~sufficiently~~ easily adopted for a small-sized injection molding machine with the comparatively small inside diameter of the melting cylinder ~~III. That is because~~ 111. In other words, since the melting cylinder 111 ~~that~~ is ~~simply~~ composed of ~~above described~~ cylinder ~~bore~~ bores 111 b and 111c, ~~111 c~~ it meets with cost reduction ~~request~~ requirements which ~~is~~ are necessary for a small-sized injection molding machine. ~~Moreover, such a small-sized injection molding machine does not cause backward flow phenomenon of molten metal so much as a large-sized injection molding machine. The above described will be easily understood by such a phenomenon that the diameter of the billet 2 in a large sized~~

~~injection molding machines is so thick and hence the peripheral length is so long that the gap through which molten metal flows backward becomes larger~~

[0082] Such a small-sized injection molding machine does not cause the molten metal backward flow problem as much as a large-sized injection molding machines do. The diameter of the billet 2 in a large-sized injection molding machines is sufficiently thick and the peripheral length is so long that the gap through which molten metal flows backward becomes enlarged.

[0083] On the other hand, in the second embodiment, molten metal 3 is not sealed by the above -described enlarged diameter seal member, but rather is sealed by a circular solidified material seal which is the solidified matter of molten metal 3 in the circular groove 212a of the cooling sleeve 212. The seal of ~~this~~ the circular solidified material seal is described ~~as follows~~ below.

[0084] In the case of magnesium ~~alloy~~ alloys, the billet 2 in the cooling sleeve 212a is controlled to be at about 400°C, which is near its softening temperature, by being powerfully cooled by cooling sleeve 212. In this condition, when the injection apparatus 1 first commences its preparatory injection molding operation, the billet 2 advances at ~~low~~ a slow speed, as is described ~~later. Then the~~ below. The molten metal ~~3~~ 3, which has already melted at the front end of the melting cylinder ~~211~~ 211, flows backward along the billet ~~2 while~~ 2, filling up the circular groove 212a ~~up~~ , and ~~finally changes~~ changing into solidified matter. This solidified matter, as the circular solidified material 201, has includes the below-listed characteristics ~~as follows~~ .

[0085] ~~First, since this~~Since the circular solidified material 201 is the solidified material of molten metal 3 that ~~is following~~ follows the shape of the space between the circular groove 212a and the billet 2, it fills the periphery space of the billet 2 with no gaps even if ~~"~~ there exists a slight eccentricity of the billet 2 with the melting cylinder 211. ~~Next, since the greater part~~ Since much of the circular solidified material 201 is fitted in the circular groove 212a in the solidified state, the circular solidified material 201 neither advances with the billet 2 nor breaks down, due to the pressure of molten metal at the time of measuring process. Consequently, ~~and consequently~~ the circular solidified material 201 does not ~~grow up backward~~ move backwards beyond circular groove 212a. ~~Moreover, since the peripheral surface of billet 2 is heated rapidly until next measuring process by the molten metal 3, the surface of the circular solidified material 201 which comes into contact with the billet 2 is kept in the appropriately softened state. Incidentally, the above described molten metal 3 is the material filled in the gap around the peripheral of the billet 2 at the time of measuring process while the billet 2 advances. Moreover, adhesion strength of the circular solidified material 201 to the billet 2 is not strong since the solidified material 201 is a solidified material which is turned rapidly when hot molten metal 3 touches comparatively low temperature of billet 2.~~

[0086] Since the peripheral surface of billet 2 is rapidly heated until the measuring process by the molten metal 3, the surface of the circular solidified material 201 which comes into contact with the billet 2 is kept in an appropriately softened state. The molten metal 3 is the material filled in the gap around the periphery of the billet 2 at the time of measuring process, while the billet 2 advances. The circular solidified material 201 is not strongly adhered to the billet 2 since the solidified material 201 is a solidified material

which is turned rapidly when hot molten metal 3 touches the comparatively low temperature of billet 2.

[0087] In addition, the gap between the inside diameter of the cylinder bore 211 a of the melting cylinder 211 and the outside diameter of the billet 2 is formed to be a few ~~nun~~millimeters so that the softened front end of the billet 2, which is enlarged slightly in diameter while advancing, does not interfere with the cylinder bore 211a. ~~Thus molten~~ Molten metal 3 ~~can enter backward~~ enters backwards behind the enlarged end of billet without being blocked, ~~which avoids~~ avoiding the existence of the space ~~,~~ into which the molten metal does not enter, and ~~hence suppresses~~ suppressing the fluctuation of the amount measured by the billet 2. This ~~phenomenon will be~~ problem is easily understood by ~~assuming such an~~ contemplating the opposite ~~phenomenon that~~ problem, in which the enlarged front end of the billet 2 repeats its ~~growing up~~ growth and breakage, and ~~so~~ repeats ~~touching~~ the contact or ~~separating~~ separation from the cylinder bore 211a. In this opposite ~~phenomenon~~ problem, the pushing area that functions as a piston ~~area~~ fluctuates ~~actually~~ .

[0088] ~~In this way~~When measuring, the circular solidified material 201 fully and stably seals the gap between the billet 2 and the melting cylinder 211 ~~well and stably~~ when billet 2 advances and pushes out molten metal ~~3 at the time of the measuring.~~ 3. The circular solidified material 201 naturally does not allow air and the like to intrude into the gap between the billet 2 and the melting cylinder 211, and also prevents backward flow of molten metal 3, ~~which also reduces~~ reducing the functional resistance of movement of the billet 2. ~~Sealing~~ The sealing action of ~~this~~ the circular solidified material 201 ~~utilizes~~ effectively utilizes the ~~characteristic~~ characteristics of light metal material,

especially that of magnesium alloy ~~, that is, the characteristics of rapidly phase changing :~~ . Specifically, the sealing action relies on the property of rapid phase changes from solid to fluid states because of ~~its~~ the high coefficient of thermal conductivity, small thermal capacity, and small latent heat.

[0089] ~~Above~~ The above-described circular solidified material 201 securely seals molten metal ~~3 surely.~~ 3. Therefore ~~this~~ the type of melting cylinder 211 can be adopted in a large-sized injection molding machine which uses thicker diameter billet rather than a small-sized injection molding machine.

[0090] ~~Next, the~~The characteristic embodiments of the other components that relate to melting cylinder 11 ~~of this~~ according to the present invention are described. In the following description, melting cylinder 11 ~~includes both~~ describes either of the first melting cylinder 111 ~~and~~ or the second melting cylinder ~~211 as far as~~ 211, where not specified.

[0091] The embodiment depicted in Figure 1 describes the layout position of the connecting passage 13b, which is formed in the end plug 13 situated on the front end of the melting cylinder 11, and further describes the installation posture of the melting cylinder 11. The connecting passage 13b is formed as a space between the cylinder bore 11a and a upper cutout of a plug portion of the end plug 13 so as to be opened at the upper portion of the cylinder bore 11a. In this case, this cutout is formed by removing the upper part horizontally so as to make a D-shaped cross-section, or by slotting a rectangular groove, such as a keyway, for example.

[0092] ~~First, such an embodiment is described with Fig. 1, that relates to the layout position of the connecting passage 13b, which is formed in the end plug 13 situated on the front end of the melting cylinder 11, and installation posture of the melting cylinder 11. The connecting passage 13b is formed as a space between the cylinder bore 11 ' a and a upper cutout of a plug portion of the end plug 13 so as to be opened at the upper portion of the cylinder bore 11 a. In this case, this cutout is formed by removing the upper part horizontally so as to make a D-shaped cross-section, or by slotting a rectangular groove such as a keyway for example.~~ The melting device 10 that contains the melting cylinder 11 is arranged in the inclined posture ~~at about~~ with approximately 3 degrees ~~with~~ of elevation relative to the front side ~~high~~ . With this arrangement of the connecting passage 13b, when the preparatory injection molding operation commences ~~first~~ , air or inert gas that has been trapped inside the melting cylinder ~~11~~ 11 is ~~surely~~ substantially purged ~~. That is because~~ , since air and gas ~~is easy to~~ easily gather in the upper part. ~~Besides, the~~ The measuring ~~becomes~~ is accurate since the ~~phenomenon~~ problem in which molten metal 3 ~~over-flows~~ unexpectedly overflows into the injection sleeve ~~21 at unexpected timings which exclude the timing~~ 21, excluding time of measuring process, is prevented by the arrangement of the connecting passage 13b and the inclined posture of the melting cylinder ~~11.~~ 11. In this case it is still better that. the whole injection molding machine including the injection sleeve 21 and the mold clamping device 30 as well as the melting cylinder ~~11~~ 11 is arranged in the inclined posture with its rear side low.

[0093] In such an embodiment, it is still better that the molten metal feeding member 15 comprises an opening and shutting device ~~70 as shown in Fig. 5. Fig. 5~~70, as depicted in Figure 5, which is an enlarged cross-sectional view showing the structure of the molten

metal feeding member 15 and its ~~vicinity.~~ surrounding area. In this drawing, the opening and shutting device 70 includes a valve seat 15b which is formed on a bottom of the material supplying hole 15a, a valve rod 71 which opens and shuts the material supplying hole 15a by touching or separating from the valve seat I5b, and a valve rod driving device 72 such as a fluid cylinder which drives the valve rod 71 ~~goes up and down. Between the valve rod 71 and the material supplying hole I5a, a gap which becomes a flow channel of molten metal 3 is secured. The fluid cylinder 72 is fixed on a bracket 73 and the upper end of the valve rod 71 is connected to a piston rod 72a of the fluid cylinder 72 by a coupling 74. The opening and shutting device 70 of above described structure prevents the molten metal 3 from dropping at unexpected timings except for the measuring timing by opening the material supplying hole 15a only at the timing of measuring, since the molten metal 3 sometimes adheres to the side wall of the material supplying hole 15a. In addition, since the material supplying hole 15a opens and closes near its bottom end, there exists no side wall of the material supplying hole I5a where molten metal 3 may adhere and sometimes drop. In this way, the opening and shutting device 70 assures accurate measuring. Incidentally, in case this type of opening and shutting device 70 is provided, the pouring hole 17 is furnished on a cover 16 so that the valve rod 71 in material supplying hole I5a is not cooled down.~~ up and down.

[0094] Between the valve rod 71 and the material supplying hole I5a, a gap exists which becomes a flow channel of molten metal 3. The fluid cylinder 72 is fixed on a bracket 73, and the upper end of the valve rod 71 is connected to a piston rod 72a of the fluid cylinder 72 by a coupling 74. The opening and shutting device 70 of the above-described structure prevents the molten metal 3 from unexpectedly dropping, except for the time of

measuring, by opening the material supplying hole 15a only at the measuring time, since the molten metal 3 can adhere to the side wall of the material supplying hole 15a.

[0095] Since the material supplying hole 15a opens and closes near its bottom end, there is no side wall of the material supplying hole15a in which molten metal 3 may adhere and sometimes drop. As such, the opening and shutting device 70 assures accurate measuring. In case this type of opening and shutting device 70 is provided, the pouring hole 17 is furnished on a cover 16 so that the valve rod 71 in material supplying hole 15a does not cool down.

[0096] In case this type of opening and shutting device 70 is provided, the measuring is performed under such conditions that molten metal is filled in the gap between the valve rod 71 and the material supplying hole 15a. The start time and end time for extruding or supplying molten metal 3 by billet 2 is controlled to coincide with the opening and shutting operation time of the material supplying hole 15a, which determines the start and end of the measuring operation, so that measuring is more accurately controlled.

[0097] ~~In case this type of opening and shutting device 70 is provided, the measuring may be performed under such a condition that molten metal is always filled with the gap between the valve rod 71 and the material supplying hole I5a. In this case, starting timing and ending timing for extruding (supplying) molten metal 3 by billet 2 is controlled to coincide with the timing of opening and shutting operation of the material supplying hole I5a, which decides the start and end of measuring operation. By above described measuring, the measuring is more accurately controlled. That is because~~ Because no temperature fall occurs at the material supplying hole ~~15~~ 15a and the valve rod 71, and

~~also~~ since adhesion of molten metal 3 to those side wall is avoided, ~~since~~ the material supplying hole ~~15~~ 15a is filled with the molten metal. Moreover, ~~another operational effect, with which~~ the melting efficiency of molten metal 3 in the melting cylinder 11 is improved ~~, is performed~~ . The ~~first is that the~~ temperature fall of molten metal 3 is avoided, whereas ~~said~~ the temperature fall occurs when molten metal 3 which faces to the connecting passage 13b touches inert gas. The ~~second is that the~~ preceding compression of the billet 2 in the melting cylinder 11 becomes possible ~~and hence~~ , making melting ~~becomes easy~~ easier.

[0098] A billet supplying device 40 is depicted in Figure 6, which is a cross-sectional view showing the billet supplying device, taken along line X - X at the central frame member 90 from Figure 1. This device includes a hopper 41 for holding a plurality of billets 2 loaded in a lined up state, a chute 42 for causing the billet to drop sequentially in the aligned state, a shutter device 43 for temporarily catching the billet and allowing the billets to drop one by one, and a holder 44 for concentrically holding the billet with an axial center of the melting cylinder 11.

[0099] Inside the hopper 41, a dividing plate 41a forming a reflex guide passage is arranged so that the billets 2 drop without accumulating. The shutter device 43 constitutes two stage shutter of an upper stage shutter and a lower stage shutter, namely a shutter plate 43a and a holding member 45, where the holding member 45 is a moving side of the holder 44. The shutter device 43 allows billets 2 to drop one by one by alternate opening and shutting operation of the shutter plate 43a and the holding member 45. Fluid cylinder 43b, which is an air cylinder, for example, is for moving the shutter plate 43a forward and backward.

<u>[0100]</u> ~~Next a billet supplying device 40 is described. Fig. 6 is a cross-sectional view showing the billet supplying device, taken along line X – X at the central frame member 90 of Fig. 1. For example, this device comprises a hopper 41 for having plural billets 2 loaded in a lined up state, a chute 42 for causing the billet to drop sequentially in an aligned state, a shutter device 43 for catching the billet temporarily and allowing the billet to drop one by one, and a holder 44 for holding the billet concentrically with an axial center of the melting cylinder 11. Inside the hopper 41, a dividing plate 41 a forming a reflex guide passage is arranged so that the billets 2 drop without building up. The shutter device 43 constitutes two stage shutter of an upper stage shutter and a lower stage shutter, namely a shutter plate 43a and a holding member 45, wherein the holding member 45 is a moving side of the holder 44. This shutter device 43 allows billets 2 to drop one by one by alternate opening and shutting operation of the shutter plate 43a and the holding member 45. Reference numeral43b denotes a fluid cylinder such as an air cylinder for moving the shutter plate 43a forward and backward. The holder 44 comprises~~ <u>The holder 44 includes</u> one set of the holding member 45 and a holding member 46, a fluid cylinder 47 such as an air cylinder, and a guide member 48 provided below the chute ~~42, in which~~ <u>42. In guide member 48,</u> the holding members 45 and 46 hold the billet 2 by gripping from both sides with a minuscule gap ~~leaving~~ <u>remaining</u>, the fluid cylinder 47 opens or closes the one side holding member 45, and the guide member 48 receives the billet 2 on a curved guide surface and leads it to the holding member 46 side. On the ~~facing~~ <u>opposing</u> sides of the holding members 45 and the holding members ~~46. almost~~ <u>46, substantially</u> semicircular arc-shaped indents 45a and 46a, which have a diameter slightly larger than the outside diameter of the billets, are formed in such a

manner that the centers of these indents 45a and 46a are aligned with the center of the cylinder bore 11 a when the holding member 45 is closed. ~~Thus the billet 2 supplied from the hopper 41 is held by the holder 44 concentrically with the center of the cylinder bore 11a. Such a billet supplying device 40 holds the billet 2 in the aligned state and makes the billet 2 fall one by one. Accordingly, it is not limited to the above described embodiment as long as it functions as described above. Incidentally, billet 2 may be heated preliminary outboard at low temperature for dehumidifying its surface.~~

[0101] The billet 2 supplied from the hopper 41 is held concentrically by the holder 44 with the center of the cylinder bore 11a. Such a billet supplying device 40 holds the billet 2 in the aligned state and makes the billet 2 fall, one by one. The present invention, however, is not limited to the above-described embodiment, and contemplates any configuration which performs the above-described functions. Incidentally, billet 2 may be heated preliminary outboard at low temperature for dehumidifying its surface.

[0102] ~~Next the~~The billet inserting device 50 is now described. ~~For example, as~~ As shown in ~~Fig.~~ Figure 1, this device ~~comprises~~ includes a hydraulic cylinder 51, a piston rod 52 subjected to controlled movement backward and forward by the hydraulic cylinder ~~51.~~ 51, and a ~~pusher~~ plunger 52a integrally formed with the end of the piston rod. The maximum movement stroke of the ~~pusher~~ plunger 52a is set ~~to~~ so that the length that rather exceeds the overall length of the billet 2. The ~~pusher~~ plunger 52a advances intermittently corresponding to one shot of injection amount at every time of measuring process. The position and the speed of the ~~pusher~~ plunger 52a is detected by a position detection device ~~. For example~~ , such as a linear ~~scales not shown in the drawing~~ scale

(not depicted), and is fed back to a control device ~~,~~ (also not ~~shown in the drawing~~ depicted).

[0103] ~~Above~~ The above-described billet inserting device 50 makes the ~~pusher~~ plunger 52a move backward over greater length than the overall length of the billet 2 at the time of replenishing so as to ensure a space for billet 2. ~~And then the~~ The billet inserting device 50 then inserts the billet 2 into the melting cylinder 11 while advancing the ~~pusher~~ plunger 52a. At the time of measuring process, the billet inserting device 50 causes an intermittent advance of the ~~pusher~~ plunger 52a ~~and feeds~~ , feeding a specified amount of molten metal 3 into the injection sleeve 21, ~~wherein~~ where the amount fed with one advance corresponds to one shot of injection amount. This type of billet inserting device 50 is not limited to a driving device of a hydraulic cylinder, as long as it ensures the above -described operation of the ~~pusher~~ plunger 52a and ~~hence~~ it can be a well-known electrical driving device ~~,~~ which drives the ~~pusher~~ plunger 52a, converting rotational movement of a servo motor to linear movement by means of a ball screw or ~~the like~~ similar mechanism.

[0104] Each component of the plunger injection device 20, combined ~~to~~with the above - described melting device 10, is described in detail with ~~Fig. 1.~~ conjunction with the description of Figure 1, above.. These components are not limited to ~~such as~~ those described below, because they are common to a conventional injection apparatus in a cold chamber die casting molding machine.

[0105] The overall structure of the plunger injection device 20 is now described. The connecting member 64, which connects the injection sleeve 21 to the plunger driving

device 60, is a cylindrical member and has a barrier wall 64a at the position close to the front side. The barrier wall 64a has a through hole into which the plunger 22 is fitted with almost no gap, and a collection pan 65 is detachably provided under the front side of the barrier wall 64a so as to prepare for leakage of molten metal 3. A pouring hole 64b for pouring inert gas is provided at an upper side of the connection member 64.

[0106] ~~First, overall structure of the plunger injection device 20 is described. The connecting member 64 which connects the injection sleeve 21 to the plunger driving device 60 is a cylindrical member and has a barrier wall 64a at the position close to the front side. The barrier wall 64a has a through hole into which the plunger 22 is fitted with almost no gap and a collection pan 65 is detachably provided under the front side of the barrier wall 64a so as to prepare for leakage of molten metal 3. Also, a pouring hole 64b for pouring inert gas is provided at an upper side of the connection member 64.~~ The connection member 64 having this type of structure is provided with a space 66 between the injection sleeve 21 and the barrier wall 64a. With this structure, even if some molten metal 3 leaked out from the base end of the injection sleeve ~~21 a little,~~ 21, it is collected in the collection pan 65. Also, since inert gas is poured into ~~this~~ the space 66, air ~~remained~~ remaining in the gap between the plunger 22 and the base end side sleeve bore 21 a is purged. This type of purging ensures the preferable ~~surroundings~~ environment for preventing oxidization of material, especially in the case of magnesium molding. ~~The~~ A small amount of inert gas to be supplied ~~can be a little~~ , because the gas is supplied ~~only~~ into the space 66 and the small tiny gap between the injection sleeve 21 and the plunger 22.

[0107] ~~Next, a~~The plunger driving device 60 is now described. For example, and as shown in ~~Fig.~~ Figure 1, this device ~~comprises~~ includes a hydraulic cylinder 61, where the piston rod 62 is subjected to controlled movement by the hydraulic cylinder 61, and a coupling 63 for connecting the piston rod 62 and the plunger 22. The plunger ~~22~~ 22, which is inserted in the injection sleeve ~~21~~ 21, is driven in the longitudinal direction forward and backward by the piston rod 62 of the hydraulic cylinder 61. The position of the plunger 22 is detected by a position detection device, ~~for example,~~ such as a linear scales ~~,~~ (not ~~shown~~ depicted), and is controlled by a controller ~~,~~ (also not shown), to which this position is fed back. The positions to which the plunger 22 can retreat are set to the positions which are located backward from the material supply mouth 21 h, and its maximum stroke is, in advance ~~designed~~ designs, set to be consistent with the maximum injection volume of the injection apparatus 1. ~~This type of plunger driving device 60 is not limited to a driving device of a hydraulic cylinder, and hence is possible to be a electrical driving device, wherein the driving device 60 drives the plunger 22 converting rotational movement of a servo motor to linear movement by means of a ball screw or the like.~~

[0108] This type of plunger driving device 60 is not limited to a driving device of a hydraulic cylinder, and hence is possible to be a electrical driving device, where the driving device 60 drives the plunger 22 converting rotational movement of a servo motor to linear movement by means of a ball screw or similar mechanism.

[0109] The plunger 22 is provided with a head section 22a having a slightly thinner diameter than the inside diameter of the injection sleeve 21 and a shaft section 22b

having a diameter slightly thinner than the head section 22a. The head section 22a also has a piston ring (not ~~shown~~depicted) provided on its periphery.

[0110] This type of a plunger driving device 60 makes plunger 22 retreat behind the material supply mouth 21h at the time of measuring process, and after the measuring process is finished, ~~makes~~ plunger 22 is made to advance in accordance with the injection speed and injection amount. ~~Then the~~ The driving device 60 controls the holding pressure, when necessary.

[0111] With the injection apparatus 1 according to the present invention, the injection molding operation is carried out, as described below, where practical injection molding operations are described first. Before the molding operation commences, a plurality of billets 2 are pre-supplied into the melting cylinder 11, and molten metal 3 equivalent to several shots of injection amount is secured in the forward side of the melting cylinder 11.

[0112] ~~With the injection apparatus 1 of this invention constructed as above described, the injection molding operation is carried out as follows. To be easily. understood, practical injection molding operation is described first. Before this molding operation commencing, plural billets 2 have been supplied into the melting cylinder 11 in advance and molten metal 3 equivalent to several shots of injection amount has been secured in the forward side of the melting cylinder 11. In this state, first of all,~~ In this state, the measuring operation is carried out. ~~First, the~~ The plunger 22 retreats beyond the material supply mouth 2Ih, and then ~~pusher~~ plunger 52 makes billet 2 advance at the specified amount. In case the opening and shutting device 70 is provided, the opening

operation of the valve rod 71 starts ~~at the same time. By above described measuring operation, molten metal 3~~ simultaneously. Molten metal 3 sufficient for one shot is transferred from the melting cylinder 10 to the injection sleeve 21 through the molten metal feeding member 15. ~~Generally, this~~ This operation is done after the molded articles that have been molded in the preceding operation are taken out, and clamping of mold half is completed. ~~At this time of measuring, the pressure of molten metal 3 never becomes so high since the material supplying hole 15a of the molten metal feeding member 15 is open. Therefore, the seal of molten metal 3 is surely done by the above described enlarged diameter seal member or the circular solidified material seal. In particular, in case the opening and shutting device 70 is provided and the material supplying hole 15a is always full of molten metal 3, opening operation of the valve rod 71 is done at the same time. Therefore the pressure of molten metal does not become particularly~~

[0113] At the time of measuring, the pressure of molten metal 3 does not become too high, since the material supplying hole 15a of the molten metal feeding member 15 is open. The seal of molten metal 3 is performed by the above described enlarged diameter seal member, or the circular solidified material seal. In particular, in case the opening and shutting device 70 is provided and the material supplying hole 15a is full of molten metal 3, opening operation of the valve rod 71 is performed at the same time. Therefore the pressure of molten metal does not become too high.

[0114] Molten metal 3 measured in the injection sleeve 21 is maintained in a molten state by the heater band ~~23. At this time,~~23, where inert gas prevents the oxidation of molten metal. ~~Next, plunger~~ Plunger 22 moves forward and injects molten metal for one shot

into the cavity ~~34~~ 34, as is conventional ~~. Next, conventional~~ done. Conventional cooling of the molded articles is ~~done, next~~ performed, the mold half is opened, and ~~then~~ the molded articles are taken out. ~~Next, the~~ The mold half is then closed again , and then measuring starts in the above described ~~way.~~ manner. Molten metal 3 in the melting cylinder 11, which is consumed at every time of the measuring, is melted and replenished before the next measuring starts.

[0115] Every time the measuring described above is repeated, the billet 2 ~~moves forward~~ intermittently moves forward. When the injection of molten metal for one billet has been done, the replenishment of billet 2 is ~~done~~ performed. This replenishing operation starts after the position detector for the ~~pusher~~ plunger 52a detects that the ~~pusher~~ plunger 52a has advanced more than overall length of one billet. ~~First, the~~ The billet inserting device 50 makes the ~~pusher~~ plunger 52a retreat more than overall length of the billet ~~2 and ensures~~ 2, ensuring that space exists behind the melting cylinder 11 for supplying the billet 2. ~~Next, the~~ The billet supplying device 40 replenishes one billet 2 to the rear of the melting cylinder 11 and then the billet inserting device 50 pushes the billet 2 into the melting cylinder 11 so that the replenishing operation completes. ~~At this time, the above described enlarged diameter seal member or the circular solidified material seal prevents the infiltration of air into the molten metal 3 in the melting cylinder 11 and backward flow of molten metal 3. Also, since the end surface and peripheral surface of the billet 2 are finished smooth, no air enters together with the billets. Therefore air is not intruded into the melting cylinder 11 once purge has been completed.~~

[0116] The above described enlarged diameter seal member or the circular solidified material seal prevent the infiltration of air into the molten metal 3 in the melting cylinder

11 and also prevent the backward flow of molten metal 3. Since the end surface and peripheral surface of the billet 2 are finished smooth, no air enters together with the billets, so air is not intruded into the melting cylinder 11 once purge has been completed.

[0117] The preparatory steps before the above-described practical injection molding operation are now described. Inert gas is injected for purging the air in the melting cylinder 11. The billet 2, which is pre-loaded into the hopper 41, is fed to the rear of the melting cylinder 11 by the billet supplying device 40, and is inserted into the melting cylinder 11 by the billet inserting device 50. A plurality of billets 2 are inserted in succession until they fills the melting cylinder 11.

[0118] ~~Next, operation of preparatory steps before above described practical injection molding operation is described. First, inert gas is injected for purging the air in the melting cylinder 11. Next, billet 2 loaded into the hopper 41 in advance is fed to the rear of the melting cylinder 11 by the billet supplying device 40, and is inserted into the melting cylinder 11 by the billet inserting device 50. In this initial stage, plural billets 2 are inserted in succession until they fills the melting cylinder 11.~~ The inserted billet 2 begins to melt from its front end of the forward portion while being heated by the heater bands 12a to 12d, and ~~being~~ is pressed forward in the melting cylinder 11. After molten metal 3 for plural shots of injection amount is finally ~~secured~~ obtained, molten metal 3 is transferred into the injection sleeve 21 while the plunger 22 retreats and the ~~pusher~~ plunger 52 advances. After molten metal 3 is supplied into the injection sleeve 21, the operation corresponding to the above -described injection operation is ~~carried out~~ performed, and air or inert gas mixed into the melting cylinder ~~11~~ 11 when forming molten metal 3 first is purged. After this purge is completed, the preparatory molding

~~operation~~ operations are repeated ~~many~~ several times, and the molding conditions are adjusted and then the preparatory operation before molding completes.

~~The invention described above is not limited to the above described embodiments, and various modifications are possible based on the gist of this invention, and these modifications do not depart from the scope of the attached claims. In particular, with respect to specific devices, such devices that basic function is complying with the gist of the invention are included in this present invention.~~

~~INDUSTRIAL APPLICABILITY~~

[0119] As described above, the injection apparatus in a cold chamber die casting molding machine of ~~this~~according to the present invention makes it possible to supply molding material in the form of billets ~~although~~ , while adopting a conventional plunger injection device. Therefore the injection apparatus ~~of this~~ according to the present invention facilitates the handling of the material and realizes the efficient melting and measuring of molding material, while succeeding the characteristics of the injection by the cold chamber die casting molding machine and making the furnace of melting device unnecessary. Moreover, the injection apparatus of this invention facilitates its handling by simplifying of itself ~~and makes the~~ , making maintenance work easy.

[0120] The invention has been described with particular illustrative embodiments. It is to be understood that the invention is not limited to the above-described embodiments and that various changes and modifications may be made by those of ordinary skill in the art without departing from the spirit and scope of the invention.